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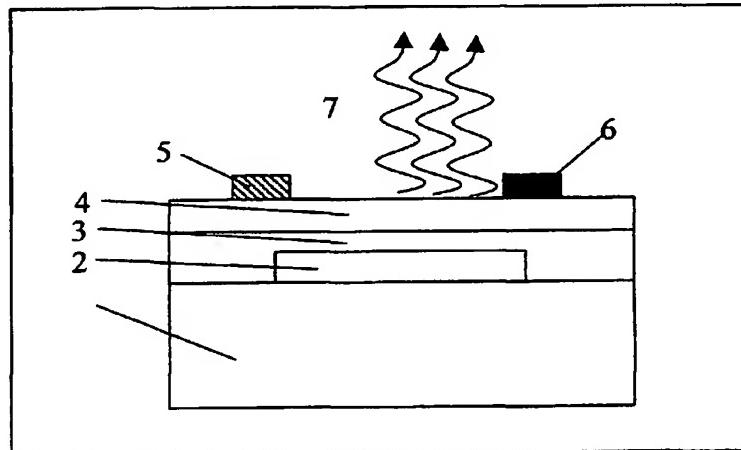
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(54) Title: ORGANIC ELECTROLUMINESCENCE DEVICES



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(57) Abstract: An electroluminescence generating device comprising e. a channel of organic semiconductor material (4), said channel being able to carry both types of charge carriers, said charge carriers being electrons and holes; f. an electron electrode (6), said electron electrode being in contact with said channel and positioned on top of a first side of said channel layer or within said channel layer, said electron electrode being able to inject electrons in said channel layer; g. a hole electrode (7), said hole electrode being spaced apart from said electron electrode, said hole electrode being in contact with said channel and positioned on top of said first side of said channel layer or within said channel layer, said hole electrode being able to inject holes into said channel; h. a control electrode (2) positioned on said first side or on a second side of said channel; whereby light emission (7) of said electroluminescence generating device can be acquired by applying an electrical potential difference between said electron electrode (6) and said hole electrode (5).



GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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EPO-Internal, PAJ, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 10, 10 October 2002 (2002-10-10) -& JP 2002 164166 A (CANON INC), 7 June 2002 (2002-06-07) abstract; figures 3-5	1-7, 9, 17, 18, 21-28
Y	-----	8, 10, 12-16, 19, 20
Y	WO 02/102117 A (PARK BYOUNG CHOO) 19 December 2002 (2002-12-19) page 15, lines 14-17	8
A	-----	1-28
Y	US 2002/182307 A1 (GAO ZHI-QIANG ET AL) 5 December 2002 (2002-12-05) paragraphs '0007!, '0012!, '0045! -----	10 -----

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 2 758 431 A (COMMISSARIAT ENERGIE ATOMIQUE) 17 July 1998 (1998-07-17) page 3, lines 4-13 - page 5, lines 15-25; figure 2 figure 4	12-14
Y	IEEE ELECTRON DEVICE LETTERS, vol. 23, no. 10, 10 October 2002 (2002-10-10), pages 618-620, XP002290060 page 618	15, 16
Y	WO 00/36664 A (KOYAMA TOMOKO ; KANEKO TAKEO (JP); SEIKO EPSON CORP (JP)) 22 June 2000 (2000-06-22) figure 1 page 2, lines 4-11 - page 3, lines 25-27 page 4, lines 1-4	19
Y	US 6 091 197 A (SUN DECAI ET AL) 18 July 2000 (2000-07-18) column 1, lines 21-26 column 1, lines 37-55; figure 1	20
A	WO 01/01452 A (PENN STATE RES FOUND) 4 January 2001 (2001-01-04) figure 1	1-28
A	US 5 977 718 A (CHRISTENSEN ALTON O) 2 November 1999 (1999-11-02) column 4, lines 24-67; figure 1	1-28
A	US 2002/167280 A1 (ODA ATSUSHI ET AL) 14 November 2002 (2002-11-14) paragraph '0061!; figure 1	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No	
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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
JP 2002164166	A	07-06-2002	NONE		
WO 02102117	A	19-12-2002	EP 1402758 A1 JP 2004522279 T WO 02102117 A1 KR 2002094999 A TW 529318 B US 2004108807 A1		31-03-2004 22-07-2004 19-12-2002 20-12-2002 21-04-2003 10-06-2004
US 2002182307	A1	05-12-2002	NONE		
FR 2758431	A	17-07-1998	FR 2758431 A1 EP 0954884 A1 WO 9831057 A1		17-07-1998 10-11-1999 16-07-1998
WO 0036664	A	22-06-2000	JP 2000182781 A JP 2000200687 A JP 2000200679 A JP 2000200688 A EP 1074054 A2 WO 0036664 A2 US 6704335 B1		30-06-2000 18-07-2000 18-07-2000 18-07-2000 07-02-2001 22-06-2000 09-03-2004
US 6091197	A	18-07-2000	NONE		
WO 0101452	A	04-01-2001	AU 7824600 A WO 0101452 A2 US 6720572 B1		31-01-2001 04-01-2001 13-04-2004
US 5977718	A	02-11-1999	NONE		
US 2002167280	A1	14-11-2002	JP 2002343578 A CN 1386039 A		29-11-2002 18-12-2002

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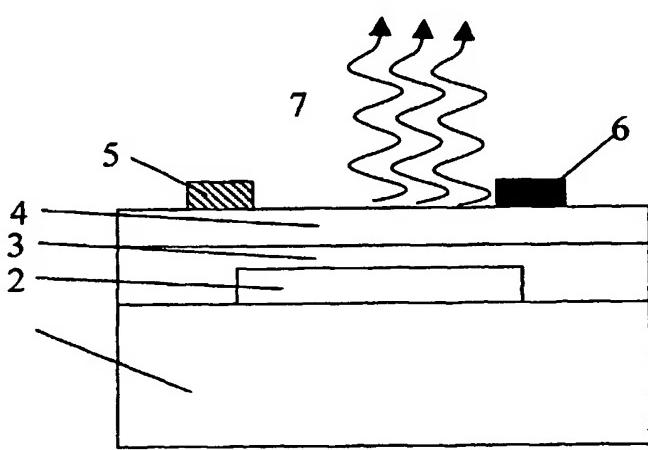
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